Observed and Modeled O^+ in the Topside Ionosphere

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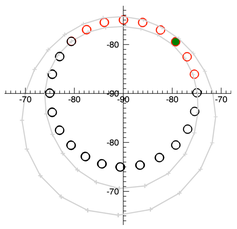
Abstract

Contemporary magnetosphere modelers are now including species dependent dynamics. Energetic O+ has significant consequences for the ring current stored energy and perhaps the timing of substorm injections. The mechanism by which thermal O+ escapes from the top of the ionosphere and into the magnetosphere is not fully understood. The history of field lines and the importance of this history as a function of MLT in driving O+ outflows has not been fully investigated to contribute to the physical explanation of various outflow features.

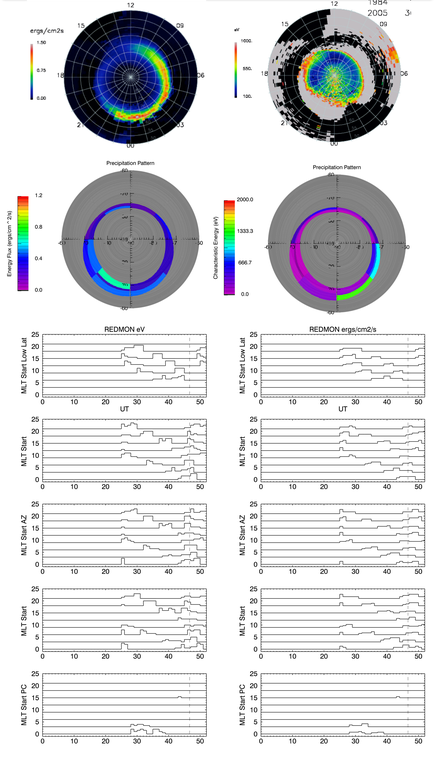
In this study, we compare observations of O+ at 850 km via DMSP with modeled fluxes computed using the FLIP model.

Corotating Flux Tubes

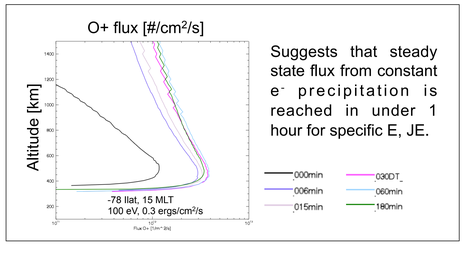


Flux tubes with fixed geographic footpoints corotate with Earth. Auroral precipitation is turned on for flux tubes inside the Feldstein oval and turned off outside. This is an example trajectory for 9 MLT.

Precipitation Patterns

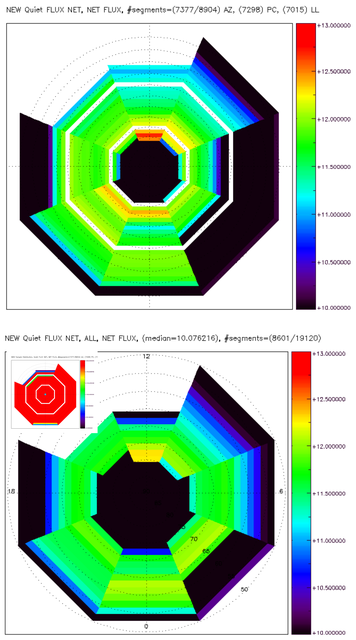


Time History at 1 Location

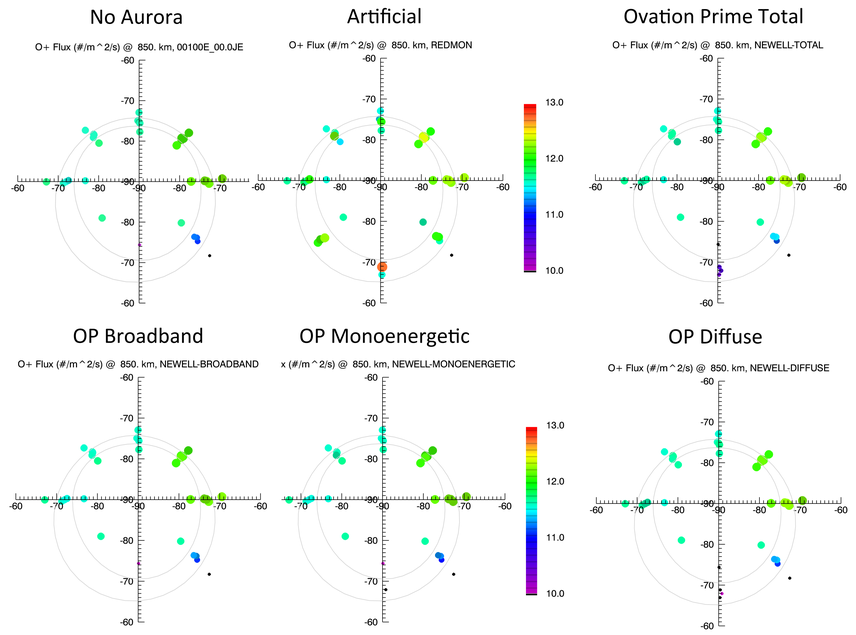


Suggests that steady state flux from constant e^- precipitation is reached in under 1 hour for specific E, JE.

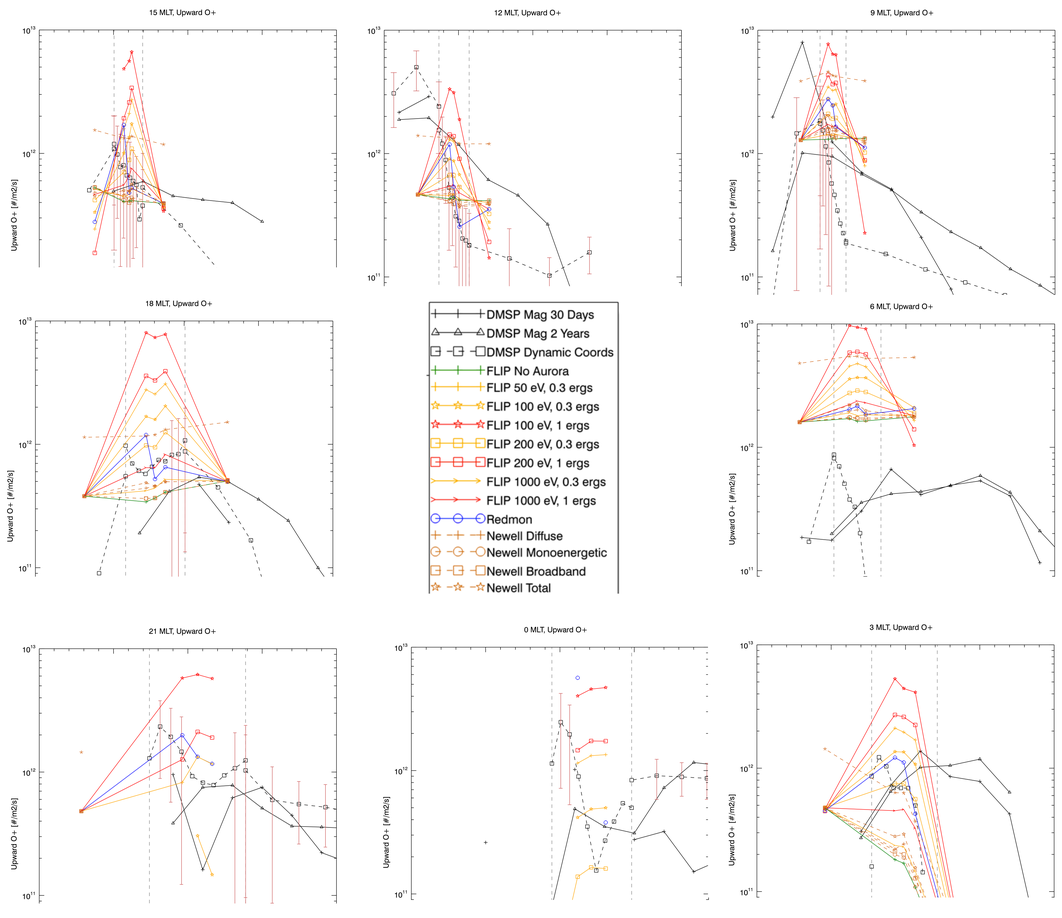
Observed O^+



Modeled O^+



Comparison over MLTs



Summary

1. While present precipitation models are generally not focused at characterizing low eV electrons, within observational variability, the combination of these models and a field line interhemispheric model can produce suffciently agreeable O^+ upward fluxes for many MLTs.
2. An artificial auroral precipitation pattern is needed to reproduce observed cusp and midnight O^+ fluxes.
3. First order modeling reproduces the dayside assymetry.
    1. We have begun a systematic parametric investigation using FLIP.
    2. Flux tube experiences different neutral environment during a day.

Field Line Interhemisphere Plasma Model

1. GEO Latitude, Longitude
2. (from desired MLat, MLT)
3. YYYY-DOY
4. Simulation Time
5. F10.7, Ap, Kp

Precipitating e- Time History
Maxwellian or Gaussian
0 - 1 ergs/cm²/s
100eV – 10keV

FLIP
(e.g. Richards and Torr 1990, Richards et al. 2010, Su et al 1998)

2 stream Fluid model that solves Continuity, Momentum and Energy equations.

Computes vertical profiles of temperature, density and velocity for various ion species (H^+, O^+, He^+, N^+, N_2^+).

Flux tube is fixed in GEO Lat, Lon => rotating with Earth.

Uses: IRI, MSIS00, HWM93

Vertical Profiles (e.g. Temp, Density, Velocity)

Placeholder for

Dayside topic

Observed Variability

etc